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Review of the Mealybug Genus *Heterococcus* (Homoptera: Coccoidea: Pseudococcidae) with a Description of a New Species[1]

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ABSTRACT

The diagnostic features of the mealybug genus *Heterococcus* are reevaluated and related genera are discussed. Previously described species are reviewed and a new species, *Heterococcus tuttlei*, is described. The latter is of economic significance to the bermudagrass seed production areas of southern California and Arizona.

The purpose of this paper is to clarify the taxonomic limits of the genus *Heterococcus*, to briefly discuss the known species of the genus, and to describe a new species which is of some economic concern in southern California and Arizona.

Ferris described *Heterococcus* in 1918 and characterized it as possessing: cerarii on posterior abdominal segments only; quinquelocular pores on both body surfaces; claws with denticle; and 9-segmented antennae. He designated as the type of the genus the only known species—*H. arenae* Ferris.

Morrison (1945) published the next major treatment of the genus. After describing 2 new genera related to *Heterococcus* and discussing a 3rd previously described relative, he characterized *Heterococcus* in the following manner: cerarii present on last 2–4 abdominal segments, although not always clearly defined; quinquelocular pores on both body surfaces; multilocular disk pores normally present (absent on 1 species); trilocular pores absent; oral-collar tubular ducts slender; circulus absent; hind femora and tibiae with translucent pores; claws with small denticle; antennae 9-segmented; both pairs of ostioles present; occurring in leaf blade sheaths of grasses.

Between 1945 and 1967, 3 more major treatments of *Heterococcus* were published; Borchsenius (1949), Ferris (1953), and McKenzie (1967). These workers added minor variations to Morrison's generic diagnosis, but the stature of the genus essentially remained unchanged.

After Morrison's work, several new species were recognized which did not strictly conform with the established limits of the genus. These species were treated by various workers in 2 ways—either a new genus was designated or the "aberrant" species was included in *Heterococcus*, but new generic limits were not established. In years past, with the large quantities of undescribed material, these methods may have been necessary. Coccidologists often use as an excuse at the end of a paper "when more species are known it will be possible to better understand this group" and leave it at that. In many groups, such as *Heterococcus*, many species have already been described, but they are hidden behind the camouflage of regionally oriented genera. If we search for these species, and reevaluate generic limits, we shall profit by a worldwide knowledge of the Coccoidea rather than a regional conglomeration.

Between 1940 and 1967 many species were described which belong to *Heterococcus* as it will be defined in this paper; many of these are "aberrant" species. They have resulted in the designation of 2 other genera: *Brevennia* Goux and *Asphodelococcus* Morrison. Aberrant species which have been added to *Heterococcus* possess the following characters which were not included within the limits of the genus as understood by Morrison, Borchsenius, Ferris, and McKenzie: no cerarii; no multilocular disk pores; at least a few trilocular pores; a circulus; coxae with translucent pores; claws without a denticle; antennae 6-, 7-, or 8-segmented; ostioles absent on head; occurring on liliaceous hosts. Since there now seem to be more "aberrant" species than "typical" species, the need for a reassessment of the limits of the genus is apparent.

We believe the species included in this paper are monophyletic and, with few exceptions, are distinctly set apart from other groups of species. Because of this conclusion, we are revising the generic limits of *Heterococcus*.

DIAGNOSIS

Heterococcus can be separated from all other pseudococcid genera by the following characteristics: elongate body; at least 1 pair of cerarii (sometimes indicated only by 1 pair of long setae); quinquelocular pores scattered over both body surfaces, smaller than multilocular disk pores; oral-collar tubular ducts at least 2 times longer than wide; circulus absent, or if present, only 1 in number, small, oval in form, never laterally elongate; tarsal digitules setose; occurring in leaf sheaths of Cyperaceae, Gramineae, and Liliaceae.

Other characters of importance, but of a less diagnostic nature include: anal lobes apical; cerarii present on last 1–4 abdominal segments, rarely with weakly developed pair on head; multilocular disk pores normally present, absent on 2 species; trilocular pores normally absent, if present, most abundant in cerarii and near spiracles, scattered in reduced numbers elsewhere; minute circular pores usually present; dorsal body setae noticeably shorter than those on venter; anal ring dorsal, with 2 rows of pores and 6 setae; legs normally elongate, slender, rarely robust;

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hind coxae normally without translucent pores, present on 4 species; hind femora and tibiae with these pores normally present; claw digitules capitate and extending slightly beyond tip of claw; claws with or without denticle; antennae possessing 9–6 segments; ostioles present, often restricted to abdomen.

GENERIC RELATIONSHIPS

Morrison (1945) discussed 4 closely related genera. One of these, *Asphodelococcus,* which he described as new, is here considered a synonym of *Heterococcus.* Two of the remaining 3 genera have recently had their component species redescribed.

De Lotto (1957, 1958) redescribed the 2 included species of *Annulococcus* James. From these descriptions, it is readily apparent that *Annulococcus* is quite different from *Heterococcus.* The genera are similar in possessing quinquelocular pores on both body surfaces, but *Annulicoccus* differs in possessing the following characters: at least traces of cerarii along the entire body margin; quinquelocular pores which are conspicuously larger than multilocular disk pores; oral-collar tubular ducts short, about as long as wide; dorsal body setae about same size as those on venter; circuli 3 or 4; occurring on roots of grasses.

Williams (1960) redescribed the only known species of *Laingiococcus* Morrison. It is again apparent that this genus is quite distinct from *Heterococcus.* These genera are similar in possessing quinquelocular pores on both body surfaces and elongate tubular ducts, but *Laingiococcus* differs as follows: body rotund; anal lobes not apical; cerarii absent; dorsal body setae about same length as those on venter; circulus laterally extended; ostioles absent; not occurring in sheaths of host; recorded on *Cocos, Ficus,* and *Maesa.*

The remaining genus discussed by Morrison (1945) is *Lacombia* Goux. Although *Lacombia* superficially appears similar to *Heterococcus,* it can easily be separated. *Lacombia* either has no dorsal quinquelocular pores or they are limited to the extreme lateral areas. The tubular ducts have a small, heavily sclerotized rim. *Lacombia* is not found in the sheaths of grasses; instead, it is known only from the roots of *Lupinus.*

Several other genera are now known which are close to *Heterococcus.* At the present time, without examining representative species, they seem distinct.

The genus *Boreococcus* Danzig, a monotypic Russian genus, is distinctive in possessing: numerous multilocular disk pores over all areas of both body surfaces; quinquelocular pores in cerarii only or with these pores completely absent. In other respects *Boreococcus* agrees well with *Heterococcus,* even to infesting the leaf sheaths of Gramineae.

The genus *Coleococcus* Borchsenius also is similar to *Heterococcus,* but differs in possessing: capitate tarsal digitules and quinquelocular pores which are limited to the venter of the abdomen. In other regards, it falls within the designated limits of *Heterococcus.*

The genus *Heterococcopsis* Borchsenius was originally established to contain species similar to *Heterococcus,* but which possess trilocular pores. Although this character would not exclude *Heterococcopsis* from *Heterococcus,* other characteristics make it quite distinct from the latter genus. The 2 species *Heterococcopsis lonicerae* Borchsenius and *H. opertus* Borchsenius are quite different from one another. *H. lonicerae,* the type of the genus, differs from species of *Heterococcus* in possessing the following characters: 3 circuli; an oval body; occurring on branches and shoots of *Lonicera* (Caprifoliaceae). Through the courtesy of E. M. Danzig, Zoological Institute of the Academy of Science, USSR, it has been possible for us to see a specimen of *H. opertus.* It is very similiar to species of *Heterococcus,* but differs in possessing 8 pairs of cerarii, 2 of which are situated on the head.

Pseudorhodania Borchsenius is a monotypic genus which is very similar to *Heterococcus.* It differs in only the oval shape of the body and its habit of occurring on the roots of its host.

Stachycoccus Borchsenius is a monotypic genus which is somewhat similar to *Heterococcus.* It differs in the oval shape of the body and in possessing a laterally elongated circulus.

GENERIC SYNONOMY

Heterococcus Ferris, 1918: 65.
Brevennia Goux, 1940: 58 (NEW SYNONYMY).
Asphodelococcus Morrison, 1945: 41 (NEW SYNONYMY).

Since 2 genera have been placed as synonyms of *Heterococcus,* a brief comment on each of them seems of value. *Asphodelococcus* Morrison was established to contain species possessing: no multilocular disk pores; trilocular pores which are scattered over both body surfaces and are concentrated near spiracles and in cerarii; tubular ducts which protrude above dermal surface; and 6-segmented antennae. Each of these features is known to occur on otherwise typical species of *Heterococcus.*

Brevennia Goux was established to contain species possessing: no denticle on the claw; 6- or 7-segmented antennae; and trilocular pores near spiracles. Several species included in this paper possess these features and are otherwise characteristic representatives of *Heterococcus.*

TREATMENT OF SPECIES

The various species that we believe to be representatives of the genus *Heterococcus* are brought together in this paper. By examining at least the published descriptions of these species it has been possible to formulate a workable generic diagnosis. Since specimens were not normally examined, we have not tried to compare the species. It is likely that there are several synonyms, but they will have to await a more detailed treatment.

Species Groups

The 17 species of *Heterococcus* can be divided into 4 groups. Although 1 or 2 annectant species do occur,

these groups are distinctive enough to warrant mention. The groups and their included species are:

1.
The Tuttlei group
tuttlei, n. sp.
filictus De Lotto
krishtali (Tereznikova)
nigeriensis Williams
pulverarius (Newstead)
tetraporus (Goux)
femoralis (Borchsenius) (?)

2.
The Arenae group
arenae Ferris
abludens Borchsenius
biporus (Goux)
confertus Borchsenius
cyperi (Hall)
tritici (Kiritchenko)
femoralis (Borchsenius) (?)

3.
The Nudus group
nudus (Green)
borkhsenii Morrison
occidentalis Morrison

4.
The Asphodeli group
asphodeli (Bodenheimer)

The Tuttlei group possesses the following diagnostic characters: 6- or 7-segmented antennae; multilocular disk pores present on both body surfaces; trilocular pores present somewhere on body; no denticle on claws; and cerarii definite, with conical cerarian setae.

The Arenae group possesses: 9- or 8-segmented antennae; no multilocular disk pores, or pores on venter only; no trilocular pores; denticle on claws; and cerarii indefinite, normally with slender cerarian setae.

The Nudus group possesses: 9- or 8-segmented antennae; multilocular disk pores which are present on both body surfaces; no trilocular pores; denticle on claws; and definite cerarii, with conical cerarian setae.

The Asphodeli group possesses: 6- or 7-segmented antennae; no multilocular disk pores; trilocular pores on both body surfaces; and definite cerarii, with conical cerarian setae.

FEMALES

Heterococcus abludens Borchsenius

Heterococcus abludens Borchsenius, 1962: 238.

Specimens were not examined. The following information was taken from Borchsenius (1962). Occurring in Yunan Province, China.

Body elongate, somewhat pyriform; cerarii each with 2 slender setae, present on anal lobes only; quinquelocular pores scattered over both body surfaces; multilocular disk pores restricted to venter of posterior 3 abdominal segments, larger than quinquelocular pores; trilocular pores absent; oral-collar tubular ducts elongate; anal ring with 3 or 4 rows of pores, otherwise normal for genus; circulus absent; legs small, elongate; translucent pores apparently absent; tarsal digitules setose; claws with denticle; antennae 6- or 7-segmented; ostioles small, present on abdomen and thorax; present in leaf sheaths of Gramineae.

Notes.—This species is a typical member of the Arenae group except it possesses 6-segmented antennae, a character common to the Tuttuei group.

Heterococcus arenae Ferris

Sand mealybug

(Fig. 1)

Heterococcus arenae Ferris, 1918: 65.

Type-material.—We have chosen from the syntypes and marked as lectotype an adult female mounted alone on a slide which is labeled "*Heterococcus arenae* n. sp. Holotype, From *Poa douglasii,* Dunes near Pacific Grove, Calif., Dec. 1, 1917 G. F. Ferris, TYPE" (deposited at University of California, Davis). In addition, there are 4 paralectotypes.

Distribution.—California, Idaho, New Mexico, and Wyoming.

Recognition Characters.—Adult female, mounted, 1.65–3.81 mm long, 0.58–1.56 mm wide. Body elongate.

DORSUM with 2 or 3 indefinite pairs of cerarii. Anal lobe cerarii each with 2 definitely paired, elongate setae, 1 or 2 shorter auxiliary setae, and a few quinquelocular pores. Penultimate cerarii each with 2 definitely paired, elongate setae and 1 or 2 quinquelocular pores. Antepenultimate cerarii each represented by 1 elongate seta. Trilocular and minute circular pores absent. Quinquelocular pores normally of one size, lightly scattered over surface, smaller than multiloculars. Multilocular disk pores absent. Oral-collar tubular ducts elongate, normally present in small numbers over entire surface, occasionally restricted to abdomen, often showing signs of rim. With reduced number of small, slightly conical body setae.

Anal ring dorsal, often touching abdominal apex, with 2 rows of setae, outer row weakly developed; 6 anal ring setae ca. 1½ times as long as greatest diameter of ring.

VENTER with multilocular disk pores present on last 3 abdominal segments, restricted to posterior margin of abdominal segment 7, rarely absent on this segment. Quinquelocular pores of same size and distribution as on dorsum. Trilocular and minute circular pores absent. Oral-collar tubular ducts elongate, in transverse rows across most abdominal segments, in reduced numbers on thorax, normally absent on head. Body setae noticeably longer and more slender than those on dorsum.

Circulus rarely present (Fig. 1), normally absent. Legs slender, hind coxae dorsally with 10–64 translucent pores, ventrally with 10–40; hind femora dorsally with 3–22 pores, absent ventrally; hind tibiae dorsally with 5–22 pores, absent ventrally; claws with denticle. Antennae normally 9-segmented, rarely with 8 segments. Ostioles present on abdomen and thorax.

This species occurs in the leaf blade sheaths of its grass host.

Notes.—Since this species is the type of *Heterococcus,* and since the characteristics of the cerarii, the circulus, the translucent pores on the legs, and the multilocular disk pores are rather unusual, a new illustration is here presented. The specimen illustrated is quite similar to the lectotype, differing only in

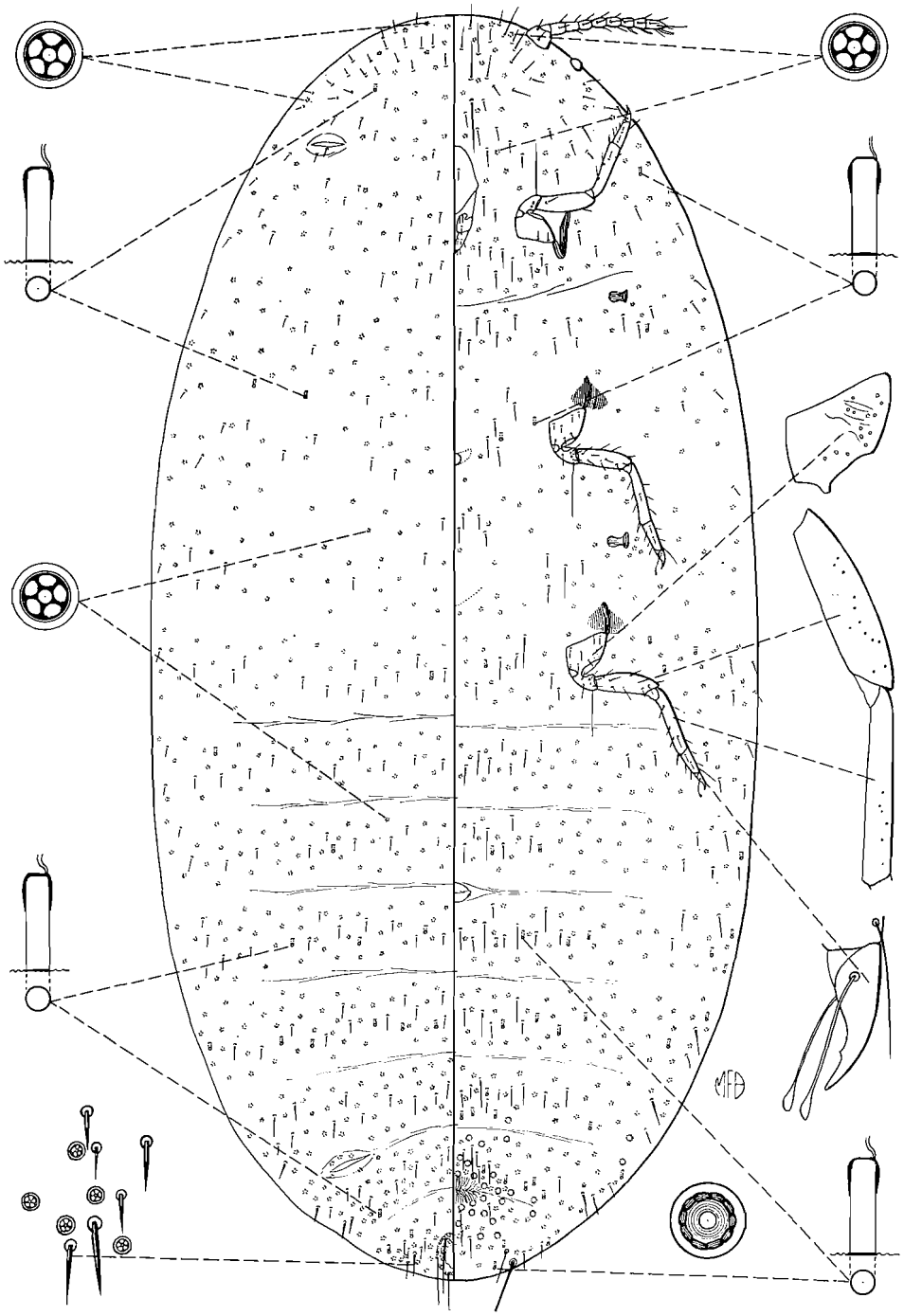

FIG. 1.—Adult female *H. arenae*. (Specimen collected 1 mile W Whiskeytown, Shasta County, Calif., July 18, 1966; on (?) Gramineae.)

the possession of a circulus. This species is a typical member of the Arenae group.

Heterococcus asphodeli (Bodenheimer) (New Combination)

Ripersia asphodeli Bodenheimer, 1927: 178.
Asphodelococcus asphodeli, Morrison 1945: 42.

Through the courtesy of Miss Louise M. Russell of the Systematic Entomology Laboratory, Agricultural Research Service, USDA, it has been possible for us to see 4 specimens of this species which are probably topotypic. Occurring in Israel.

Body elongate; cerarii with 2 short, conical setae, developed on last 2 or 3 abdominal segments; quinquelocular pores numerous over both body surfaces; multilocular disk pores absent; trilocular pores present in small numbers over both body surfaces, concentrated in cerarii, near ostiole openings, and near spiracles; oral-collar tubular ducts elongate, orifice protruding above dermal surface; anal ring normal for genus; circulus absent; legs elongate, slender; translucent pores present on hind tibiae; tarsal digitules setose; claws with denticle; antennae 6-segmented; ostioles present on abdomen and head; present in leaf sheaths of Liliaceae.

Notes.—This is the only species included in the Asphodeli group.

Heterococcus biporus (Goux)

Phenacoccus biporus Goux, 1937: 253.
Heterococcus biporus, Morrison 1945: 48.

Specimens were not examined. The following information has been gleaned from Goux (1937). Occurring in France.

Body elongate; cerarii indefinite, represented by paired elongate setae on terminal 2 abdominal segments; quinquelocular pores scattered over both body surfaces; multilocular disk pores absent; trilocular pores absent; oral-collar tubular ducts elongate; anal ring normal for genus; circulus absent; legs abnormally robust; translucent pores present on hind femora; tarsal digitules setose; claws with poorly developed denticle; antennae 9- or 8-segmented; ostioles present posteriorly only; occurring on grass, but position on host unknown.

Notes.—This species is a typical member of the Arenae group.

Heterococcus borkhsenii Morrison

Heterococcus borkhsenii Morrison, 1945: 48.

Specimens were not examined. The following information was taken from Borchsenius (1937, 1949, 1950). Occurring in Ukraine, Northern Caucasus, Abkhazia, Armenia, Azerbaidzhan, Georgia, USSR.

Body elongate; cerarii each with 2 slender, conical setae, present on posterior 2 or 3 abdominal segments; quinquelocular pores scattered over both body surfaces; multilocular disk pores in transverse rows on both surfaces of abdomen, present in small numbers on lateral margins of thorax and head, larger than quinquelocular pores; trilocular pores absent; oral-collar tubular ducts elongate; anal ring normal for genus; circulus absent; legs slender; translucent pores apparently present on hind femora and tibiae; tarsal digitules probably setose; claws with small denticle; antennae 9-segmented, ostioles present on abdomen and thorax; present in leaf sheaths of Gramineae.

Notes.—This species was first discussed by Borchsenius (1937) under the name of *Heterococcus tritici* (Kiritchenko). It was apparent to Morrison (1945) that the species discussed by Borchsenius was different from the species described by Kiritchenko. Although Morrison never saw the actual specimens upon which Borchsenius based his discussion, he described them as a new species, *H. borkhsenii.*

Notes.—This species is a typical member of the Nudus group.

Heterococcus confertus Borchsenius

Heterococcus confertus Borchsenius, 1949: 267.

Specimens have not been examined. The following information was gleaned from Borchsenius (1949, 1950). Occurring in Tadzhikistan, USSR.

Body elongate; cerarii each with 2 or 3 slender setae, present on posterior 2 abdominal segments; quinquelocular pores scattered over both body surfaces; multilocular disk pores present on venter of posterior 3 abdominal segments, larger than quinquelocular pores; trilocular pores absent; oral-collar tubular ducts elongate; anal ring normal for genus; circulus absent; legs slender; translucent pores present on hind coxae, possibly present on hind femora and tibiae also; tarsal digitules probably setose; claws with denticle; antennae 9-segmented; ostioles present on abdomen and thorax; present in sheaths of Gramineae.

Notes.—This species is a typical member of the Arenae group.

Heterococcus cyperi (Hall)

Phenacoccus cyperi Hall, 1926: 4.
Heterococcus cyperi, Ezzat 1960: 47.

Specimens were not examined. The following information was taken from Ezzat (1960) and Hall (1926). Occurring in Egypt.

Body elongate; cerarii "absent," although Ezzat's illustration indicates a pair of elongate setae on the anal lobes as on *H. biporus;* quinquelocular pores scattered over both body surfaces; multilocular disk pores restricted to venter of posterior 3 abdominal segments, larger than quinquelocular pores; trilocular pores absent; oral-collar tubular ducts elongate; anal ring with only single row of pores, although outer row may be so lightly sclerotized as to be visible only on a good preparation as is true on several species of *Phenacoccus* Cockerell; circulus absent; legs small, robust; translucent pores absent; tarsal digitules setose; claws with small denticle; antennae 8- or normally 9-segmented; ostioles present on abdomen and thorax; occurring in leaf sheaths of Cyperaceae.

Notes.—This species is a typical member of the Arenae group.

Heterococcus femoralis (Borchsenius) (New Combination)

Brevennia femoralis Borchsenius, 1949: 270.

Specimens have not been examined. The following information was taken from Borchsenius (1949). Occurring in Tadzhikistan and Azerbaidzhan, USSR.

Body elongate; cerarii each with 2 slender setae, present on last 2 or 3 abdominal segments; quinquelocular pores scattered over both body surfaces; multilocular disk pores present along body margin with transverse rows of these pores surrounding vulva, larger than quinquelocular pores; trilocular pores present near spiracles only; oral-collar tubular ducts elongate; anal ring normal for genus; circulus absent; legs short, robust, translucent pores present on hind coxae, femora, and tibiae; tarsal digitules setose; claws without denticle; antennae 6- or 7-segmented; ostioles present on abdomen only; present in leaf sheaths of Gramineae.

Notes.—This species possesses diagnostic characters of 2 species groups. It is similar to the Tuttlei group in possessing: 6- or 7-segmented antennae; trilocular pores; and denticle on claws. It is similar to the Arenae group in possessing: multilocular disk pores on both body surfaces; and indefinite cerarii with slender cerarian setae.

Heterococcus filictus De Lotto

Heterococcus filictus De Lotto, 1967: 4.

Specimens were not examined. The following summary of pertinent characters was gleaned from De Lotto's excellent description. Occurring in South Africa.

Body elongate; cerarii each with 1–3 slender conical setae, present on last 4 abdominal segments; quinquelocular pores scattered over both body surfaces; multilocular disk pores present along body margin with transverse rows present on both body surfaces of abdominal segments 9 through 5, larger than quinquelocular pores; trilocular pores present near spiracles and in cerarii; oral-collar tubular ducts elongate; anal ring normal for genus; circulus absent; legs elongate, slender; translucent pores on hind femora and tibiae; tarsal digitules setose; claws without denticle; antennae 6- or 7-segmented; ostioles present on abdomen only; collected on roots of Gramineae.

Notes.—There is no doubt that this species should be included in *Heterococcus,* because it is a typical member of the Tuttlei group.

Heterococcus krishtali (Tereznikova) (New Combination)

Brevennia krishtali Tereznikova, 1962: 122.

We have not examined specimens of this species. The following information was taken from the excellent description and illustration presented by Tereznikova. Occurring in Ukraine, USSR.

Body elongate; cerarii each with 2 conical setae, present on anal lobes only; quinquelocular pores scattered over both body surfaces; multilocular disk pores present along lateral margin of body, in transverse rows dorsally on abdominal segments 9 through 7, ventrally on segments 9 through 5, larger than quinquelocular pores; trilocular pores present near spiracles; oral-collar tubular ducts elongate; anal ring normal for genus; circulus absent; legs small, robust; translucent pores absent; tarsal digitules setose; claws without denticle; antennae 6-segmented; ostioles present on abdomen only; occurring in leaf sheaths of grass.

Notes.—This species is a typical member of the Tuttlei group.

Heterococcus nigeriensis Williams

Heterococcus nigeriensis Williams, 1961: 671.

Through the courtesy of D. J. Williams it has been possible for us to see a topotype specimen of this species. Since Williams (1961) presented an excellent illustration and description, it is unnecessary for us to redescribe this species in detail even though specimens have been examined. Occurring in Nigeria.

Body elongate; cerarii each with 2 slender, conical setae, present on last 2 abdominal segments; quinquelocular pores present on both body surfaces; multilocular disk pores present along body margin and in transverse rows both dorsally and ventrally on abdominal segments 9 through 5, larger than quinquelocular pores; trilocular pores present near spiracles and cerarii, near ostiole openings, on dorsomedial portion of abdomen, and on lateral areas of thorax and head; oral-collar tubular ducts elongate; anal ring normal for genus; circulus normally absent, if present small and oval; legs elongate, slender; translucent pores present on hind femora and tibiae; tarsal digitules setose; claws without denticle; antennae 8- or 9-segmented; ostioles present on abdomen only; occurring in leaf sheaths or in distorted leaf rolls of grass host.

Notes.—This species is an atypical member of the Tuttlei group. It differs in the possession of 8- or 9-segmented antennae. We have seen another species, through the courtesy of E. M. Danzig, Zoological Institute of the Academy of Sciences, USSR, which is quite similar to *H. nigeriensis.* Because these specimens were heavily parasitized, we are unable to describe them.

Heterococcus nudus (Green)

Naked grass mealybug

(Fig. 2)

Phenacoccus nudus Green, 1926: 172.
Heterococcus nudus, Green 1928: 21.
Heterococcus graminicola Morrison, 1945: 48.
Heterococcus variabilis Schmutterer, 1958: 18.

Because this species has recently been wrongly considered a synonym of *H. pulverarius,* we believe it important to give a detailed redescription of it to clarify its nomenclatorial position. We have not seen authentic type material of *Phenacoccus nudus,* but we have seen specimens from England which agree

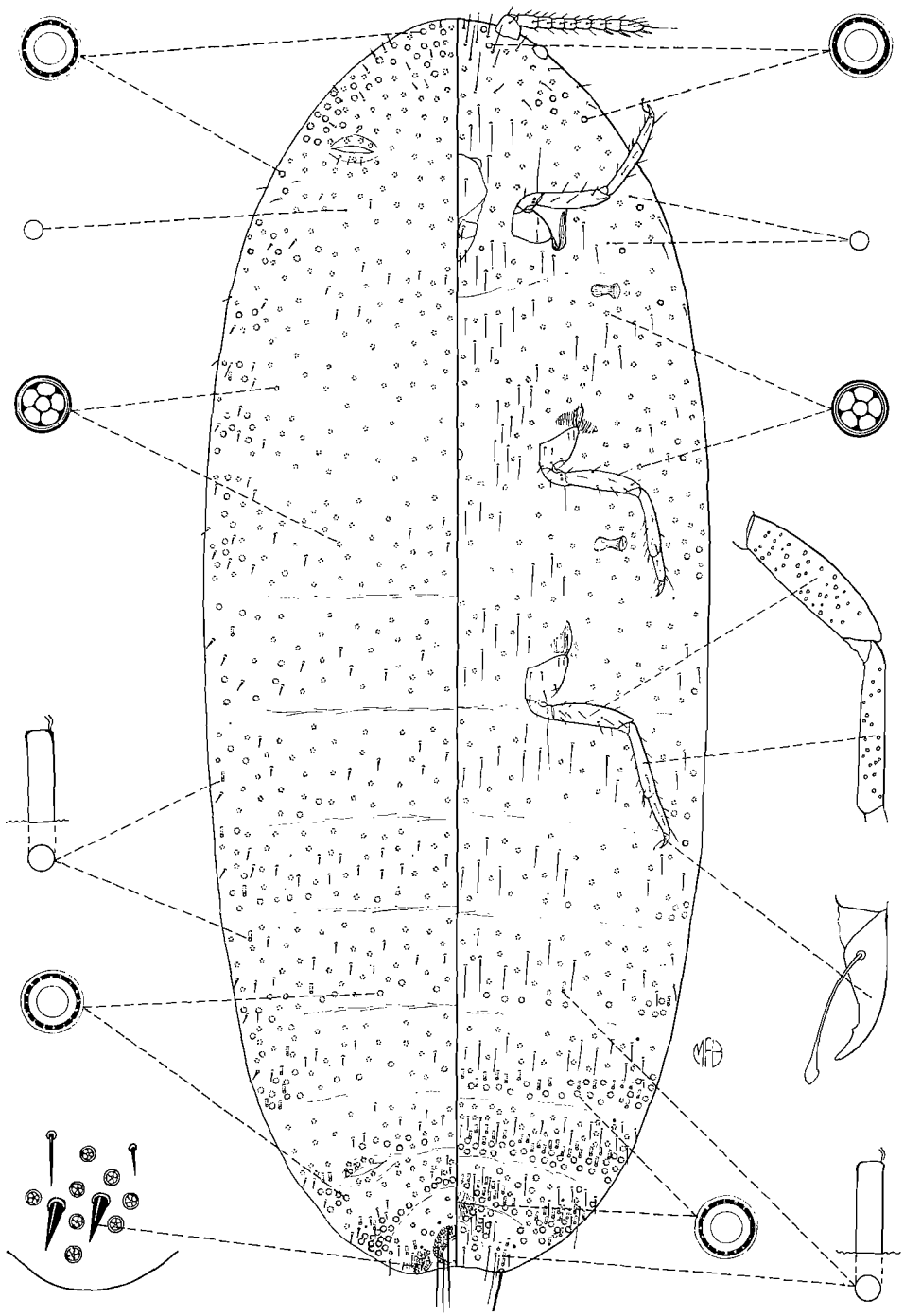

FIG. 2.—Adult female *H. nudus*. (Specimen from Ken Surrey, England, June 16, 1963; on *Agropyron repens* (Gramineae).)

well with the type description. We thank D. J. Williams of the British Museum (Natural History) for making this material available.

In addition, the type-series of *H. variabilis* has been examined; the holotype and 3 paratypes are typical of *H. nudus*.

Distribution.—Europe and the United States.

Recognition Characters.—Adult females range from 2.50 to 3.15 mm long, 0.94–1.46 mm wide. Body elongate.

DORSUM with 3–5 pairs of cerarii. Anal lobe cerarii each with 2 conical setae, 2–5 auxiliary setae, and small cluster of associated quinquelocular pores. Cerarii on abdominal segments 8 and 7 definite, each with small pair of conical setae and 2 or 3 quinquelocular pores. Cerarii on abdominal segments 6 and 5 weakly developed, each with pair of thin, conical setae which are definitely larger than dorsal body setae, these cerarian setae widely separated, with no associated quinquelocular pores. Ocular cerarius rarely weakly indicated. Trilocular pores absent, replaced by 2 sizes of quinquelocular pores which are numerous over dorsum, smaller size more abundant. Minute circular pores rare. Multilocular disk pores twice size of quinquelocular pores, present from abdominal segment 9 through head, absent in medial areas from abdominal segments 4 or 3 through head. Oral-collar tubular ducts elongate, restricted to margins of abdomen and thorax. Dorsum beset sparingly with small conical or slightly lanceolate body setae.

Anal ring apical, with 2 or 3 rows of pores, if with 3, outer 2 rows weakly developed; 6 anal ring setae about twice as long as greatest diameter of ring.

VENTER with multilocular disk pores present along lateral margin from abdominal segment 9 through head, present in transverse rows from abdominal segment 9 through segments 5 or 4. Quinquelocular pores same size, shape, and distribution as on dorsum. Minute circular pores rare, restricted to lateral margin. Oral-collar tubular ducts same as on dorsum, present on posterior margin of abdominal segments 9 through 6, normally with 2 or 3 such pores on abdominal segment 5. Body setae elongate, noticeably longer than those on dorsum.

Circulus rarely present, normally absent. Legs slender; hind coxae with translucent pores absent; hind femora dorsally with 18–47 translucent pores, absent ventrally; hind tibiae dorsally with 20–35 translucent pores, absent ventrally; tarsal digitules setose; claws with denticle. Antennae normally 9-segmented rarely with 8 segments. Ostioles present on abdomen and thorax.

This species occurs in the leaf sheaths of Gramineae.

Notes.—*H. nudus* has been confused with *H. pulverarius,* but is easily distinguished from it in possessing: 8- or 9-segmented antennae; slender legs; and no trilocular pores. *H. pulverarius,* on the other hand, possesses: 6- or 7-segmented antennae; robust legs; and trilocular pores.

H. nudus is a characteristic representative of the Nudus group.

Heterococcus occidentalis Morrison

Heterococcus occidentalis Morrison, 1945: 53.

Specimens not examined. The following information has been gleaned from Morrison (1945) and Ferris (1953). Occurring in the State of Washington, USA.

Body elongate; cerarii each with 2 conical setae, present on posterior 2 or 3 abdominal segments; quinquelocular pores scattered over both body surfaces; multilocular disk pores present along lateral margins and in transverse rows dorsally and ventrally on posterior 4 or 5 abdominal segments, larger than quinquelocular pores; trilocular pores absent; oral-collar tubular ducts elongate; anal ring with 6 abnormally stout setae, otherwise normal for genus; circulus absent; legs elongate, slender; translucent pores present on hind femora and tibiae; tibial digitules setose; claw with denticle; antennae 9-segmented; ostioles inconspicuous, present on abdomen and head; occurring on grass.

It is possible that this species is based on only a series of aberrant specimens of *H. nudus* (Green). It is a typical member of the Nudus group.

Heterococcus pulverarius (Newstead)

Bluegrass mealybug

(Fig. 3)

Ripersia pulverarius Newstead, 1892: 145.
Heterococcus pulverarius, Williams 1961: 673.

Since the nomenclatorial problems involving this species and *H. nudus* are confusing (Williams 1961), it has seemed important to give a detailed description and illustration of both species. We thank W. N. Ellis, Holland, H. Schmutterer, Germany and D. J. Williams, England for making material of these species available for study.

Type-material.—Two syntype specimens on a single slide have been examined. The right label reads "Ripersia pulveraria News. nsp. On Agrostis Sandiway Cheshire Aug 1891. Parasitized ♀ R. N. Couer." The left label reads "cotypes BM 1945, 121 Restained Oct. 1918. R. F." (deposited at the British Museum (Natural History)). The adult female on the left is here designated as the lectotype and is so indicated on the slide.

The type-series of *H. variabilis* has been examined; 7 of the paratypes belong to *H. pulverarius,* the remaining 4 specimens, including the holotype, are typical of *H. nudus;* therefore *H. variabilis* is considered a synonym of *H. nudus.*

Distribution.—Europe.

Recognition Characters.—Adult female 1.00–2.75 mm long, 0.92–1.34 mm wide. Body elongate.

DORSUM with 3–4 pairs of cerarii. Anal lobe cerarii each with 2 conical setae, 1 or 2 auxiliary setae, 1 or 2 trilocular pores, and small cluster of quinquelocular pores. Remaining cerarii each with 2 conical setae, which become increasingly more separated anteriorly, and no associated quinquelocular pores. Trilocular pores rare in medial areas of abdominal segments 9 and 8 and near cerarii, more numerous on anterior

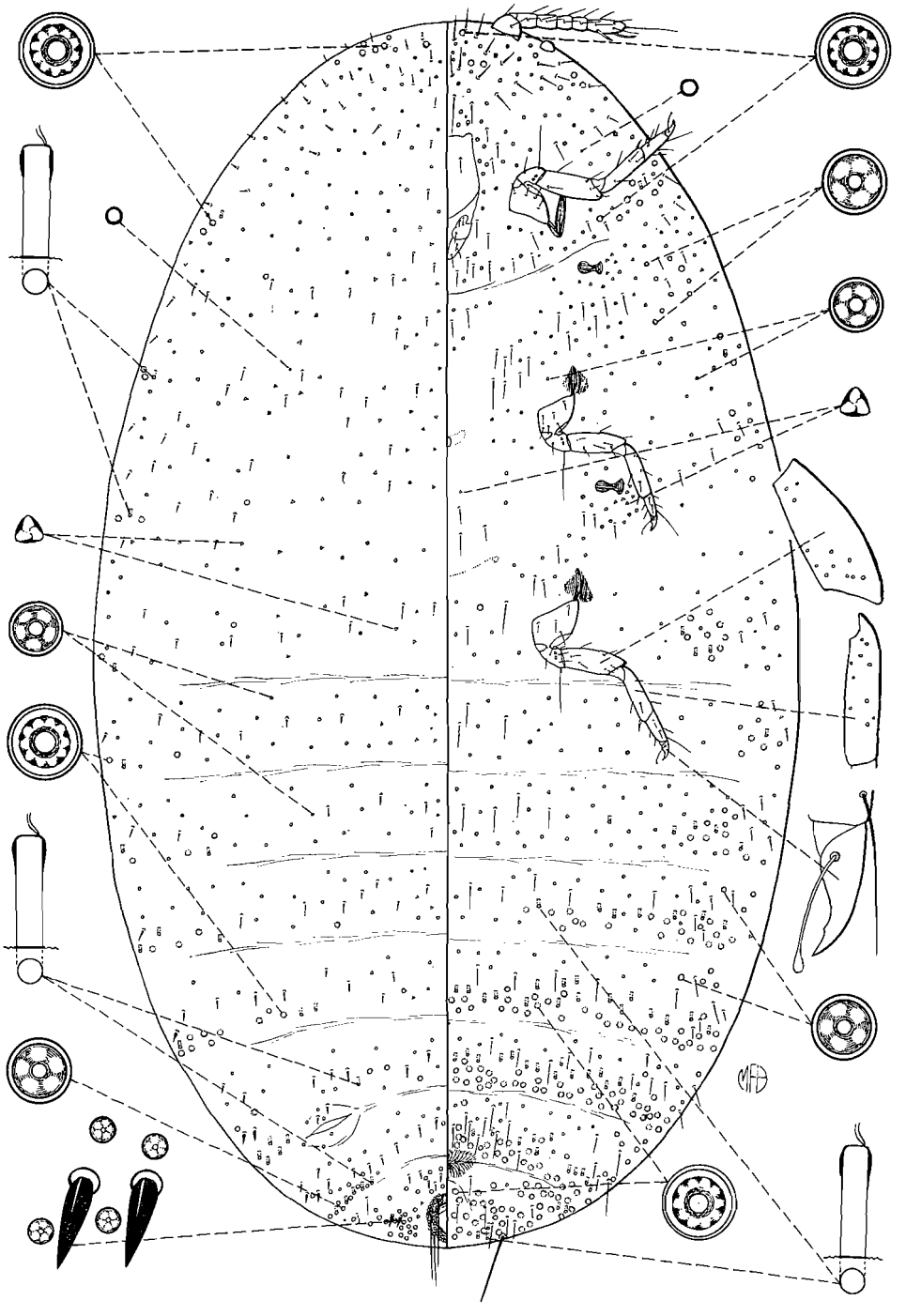

FIG. 3.—Adult female *H. pulverarius*. (Specimen from Oberammergau, Germany, Aug. 15, 1955; on *Agrostis alba* (Gramineae).)

abdominal segments and on thorax, absent on head. Minute circulars rare. Multioculars present along margin, larger than quinqueloculars. Quinqueloculars of 2 sizes, scattered over surface, larger size rare. Oral-collar tubular ducts elongate, in reduced numbers, associated with lateral clusters of multilocular disk pores. Dorsum with reduced number of small, conical, or slightly lanceolate body setae.

Anal ring apical, with 2 rows of pores, outer row weakly developed; 6 anal ring setae about twice as long as greatest diameter of ring.

VENTER with multilocular disk pores distributed from abdominal segment 9 through head, present in transverse rows along posterior margin of abdominal segments 9 through 6, in lateral clusters on remaining abdominal segments, in small clusters near legs, on lateral margins of thorax, and on head. Trilocular pores present near spiracles and on medial areas of thorax. Quinquelocular pores of same sizes and distribution as a dorsum. Minute circular pores present in small numbers on abdomen and thorax. Oral-collar tubular ducts same as on dorsum, closely associated with multilocular disk pores except absent on head. Body setae present in small numbers, becoming increasingly shorter from apex of abdomen forward through thorax, those on head elongate.

Circulus absent. Legs robust; hind coxae with translucent pores absent, hind femora dorsally with 12–22 translucent pores, absent ventrally; hind tibiae dorsally with 9–22 translucent pores, absent ventrally; tarsal digitules setose; claws with small denticle. Antennae 6- or 7-segmented. Ostioles present on abdomen only.

This species is found in leaf sheaths of Gramineae.

Variation.—Fig. 3 is not based on the lectotype because the latter is badly multilated. The lectotype differs from this description in possessing no trilocular pores near the spiracles.

Notes.—Even though the type specimens of *pulverarius* are quite different from the type-specimens of *nudus,* these species are presently considered synonymous. Since there was some evidence that specimens in the type-series of *pulverarius* had been parasitized, they were thought to be aberrant specimens of *nudus* (Williams 1961). *Ripersia pulverarius* Newstead, 1892, had priority over *Phenacoccus nudus* Green, 1928; therefore, specimens identified as *pulverarius* were normally most similar to the types of *nudus.*

After examining material of both species from England and seeing material from other parts of Europe, it is apparent that *Heterococcus nudus* and *H. pulverarius* are distinct species. Material from North America previously identified as *H. graminicola* or *H. pulverarius* should now be considered *H. nudus.* Material from the type series of *H. variabilis* is partially *H. pulverarius* and partially *H. nudus;* the holotype of *H. variabilis* is nearly identical to the type of *H. nudus.* For a comparison of *H. nudus* and *H. pulverarius* see "Notes" on *H. nudus.*

H. pulverarius is a typical member of the Tuttlei group except that it possesses a denticle on the claw and the dorsal multilocular disk pores are not abundant.

Heterococcus tetraporus (Goux) (New Combination)

Ripersia (Brevennia) tetrapora Goux, 1940: 58.

Specimens have not been examined. The following information was taken from Goux (1940). Occurring in France.

Body elongate oval; cerarii with 2 conical setae, restricted to last 2 abdominal segments; quinquelocular pores present on both body surfaces; multilocular disk pores present along lateral margins and in transverse rows both dorsally and ventrally on abdominal segments 9 through 5, larger than quinquelocular pores; trilocular pores probably present as the peculiar pores mentioned by Goux as located near spiracles; oral-collar tubular ducts elongate; anal ring normal for genus; circulus absent; legs abnormally robust, with or without translucent pores on hind tibiae; tarsal digitules setose; claws without denticle; antennae 6-segmented; occurring in leaf sheaths of grass.

Notes.—This species is a typical member of the Tuttlei group.

Heterococcus tritici (Kiritchenko)

Trionymus tritici Kiritchenko, 1932: 135.
Heterococcus tritici, Borchsenius 1937: 55 (misidentification, actually *H. borkhsenii* Morrison).
Heterococcus tritici, Borchsenius 1949: 268.

We have examined no specimens of this species. The following discussion has been taken from Kiritchenko (1932) and Borchsenius (1949, 1950). Occurring in the Southern Ukraine, USSR.

Body abnormally long, 9.0 mm; cerarii with 2 slender, conical setae, restricted to anal lobes; quinquelocular pores present on both body surfaces; multilocular disk pores present in transverse rows ventrally on abdominal segments 9 and 8, larger than quinquelocular pores; trilocular pores absent (?); oral-collar tubular ducts elongate, orifice may protrude above dermal surface; anal ring normal for genus; circulus absent; legs slender; translucent pores present on hind coxae, femora, and tibiae; tarsal digitules setose; claws with small denticle; antennae 8- or 9-segmented; both pairs of ostioles present; occurring in leaf sheaths of Gramineae.

Notes.—This species appears to be a typical member of the Arenae group except that it possesses definite cerarii with conical cerarian setae.

Heterococcus tuttlei, n. sp.

Tuttle mealybug

(Fig. 4)

Type-material. — Holotype adult female (single specimen on slide) and 45 adult paratypes in museum, University of California, Davis. Two additional paratypes are deposited in each of the following museums: British Museum (Natural History), London (BM); Instituto Nacional de Investigaciones Agricolas, Chapingo, Mexico (INIA); Museo de Historia Na-

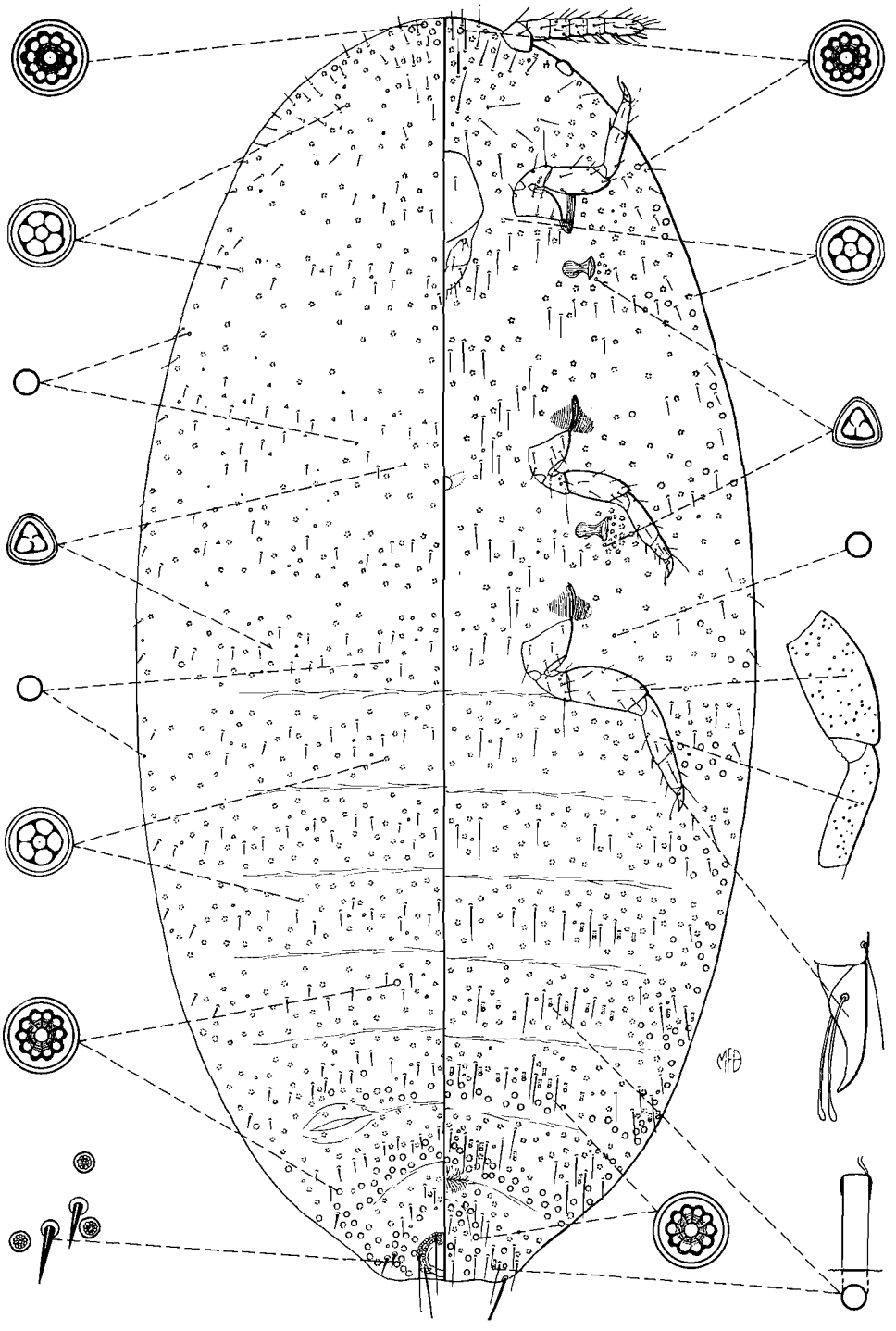

FIG. 4.—Adult female *H. tuttlei.* (Specimen from Bard, Imperial County, Calif., Nov. 7, 1967; on *Cynodon dactylon* (Gramineae).)

tural de la Cuidad de Mexico (MHNCM); United States National Collection of Coccoidea (U.S. National Museum) Washington, D. C. (USNM); University of Hawaii (UH); Virginia Polytechnic Institute, Blacksburg (VPI); Collection of Zoological Institute, Academy of Sciences of USSR, Leningrad (ZAS). Twenty-one paratypes are deposited in California Department of Agriculture, Sacramento (CDA).

Field Features.—This species first came to our attention through Miss L. M. Russell. She received the specimens from D. M. Tuttle of the University of Arizona. Dr. Tuttle reported this mealybug to be the partial cause of damage to seed crops of *Cynodon dactylon* (Gramineae) in the Yuma, Ariz., area. Although the exact effect on crop yield has not been determined, the sticky honeydew produced by these insects interferes with harvesting procedures by "gumming up" the machinery. This type of pest problem was reported by Dick and Armitage (1951) and McKenzie (1961, 1967) for *Heterococcus nudus* (= *pulverarius*) and *Trionymus haancheni* McKenzie.

Mature females are pink and the legs are yellowish-brown. A single pair of minute caudal filaments is sometimes visible. The dorsum is lightly dusted with a smooth white bloom, whereas the venter and the infested leaf sheaths are heavily dusted with a fluffy, white wax secretion. The early instars are yellow.

The mealybug infests the leaf blade sheaths of its host.

Recognition Characters.—Adult female holotype, mounted, 1.81 mm long, 0.87 mm wide (paratypes 1.23–2.85 mm long, 0.52–1.50 mm wide). Body elongate.

DORSUM with 1 definite pair of cerarii and 3 or 4 more which are weakly indicated. Anal lobe cerarii each with 2 slender, conical setae, 2 or 3 quinquelocular pores, and no basal sclerotization. Remaining 3 or 4 cerarii each indicated by only a single seta slightly longer and more robust than other dorsal body setae. Multilocular disk pores with 10 loculi or rarely with 8, present on posterior margins of abdominal segments 9 through 7, with 9 such pores on segment 6, with a few such pores along lateral margin of thorax and head. Quinquelocular pores of 1 size, abundant over entire surface, smaller than multilocular disk pores. Trilocular pores in very small numbers on abdomen, in small groups on thorax, absent on head. Minute circular pores in small numbers over surfaces. Oral-collar tubular ducts absent. Body setae noticeably smaller than those on venter.

Anal ring dorsal, situated near abdominal apex, with 2 rows of pores; each of 6 anal ring setae slightly longer than greatest diameter of ring.

VENTER with multilocular disk pores on posterior margins of abdominal segments 9 through 7, restricted to lateral margins from segment 6 through head. Quinquelocular pores abundant over entire surface. Trilocular pores lightly distributed over surface. Oral-collar tubular ducts elongate, present in transverse rows across abdominal segments 9 through 5. Body setae normal for genus.

Circulus absent. Legs unusually small and robust; hind femora dorsally with 43 and 46 small translucent pores (paratypes with 30–52), absent on ventral surface (paratypes with 0–3); hind tibiae dorsally with 19 and 12 translucent pores (paratypes with 8–17), absent on ventral surface; tarsal digitules apically acute; claw digitules capitate; claws with denticle absent. Anntennae 6- or 7-segmented.

Variation.—The paratypes vary from the holotype as follows: dorsal multilocular disk pores at times present on lateral margins of abdominal segments 6 and 5, rarely present on medial areas of segment 6, and with as many as 5 such pores along lateral margin of thorax; dorsal abdominal trilocular pores rarely less frequent than on type; dorsal oral-collar tubular ducts sometimes present on medial areas of abdominal segment 8; ventral multilocular disk pores uncommonly present on posterior margin of abdominal segment 8 and medial areas of segment 6; ventral oral-collar tubular ducts rarely absent on abdominal segment 5; small circulus rarely present; antennae rarely 7-segmented, usually with 6 segments.

Notes.—We take great pleasure in naming this species for D. M. Tuttle, who has gathered many of the specimens and the field data presented here. This species shows remarkable similarities to *H. femoralis, H. filictus, H. krishtali, H. pulverarius,* and *H. tetraporus* in possessing: 6- or 7-segmented antennae; short, robust legs; and trilocular pores. The distribution of trilocular pores over the dorsum of the anterior abdominal segments and thorax separates this species from all those mentioned except *H. pulverarius*. It is easily separated from *H. pulverarius* in possessing no denticle on claws, whereas *H. pulverarius* has a definite denticle.

H. nigeriensis also is similar to this species, but differs in possessing: trilocular pore in the cerarii; numerous multilocular disk pores along dorsolateral areas of thorax; noticeably slender legs; and 8- or 9-segmented antennae. *H. tuttlei,* on the other hand, possesses: no trilocular pores in the cerarii; less than 10 multilocular disk pores along dorsolateral areas of thorax; short, robust legs; and 6- or 7-segmented antennae.

We thank G. De Lotto and D. J. Williams for expressing their opinions as to the status of *H. tuttlei* in relation to *H. filictus* and *H. nigeriensis*. Without their assistance it would have been difficult to reach a valid conclusion as to the distinctiveness of the new species.

Specimens Examined. — ARIZONA, Yuma Co.: Yuma, XI-30-67, on *Cynodon dactylon* (Gramineae), D. M. Tuttle (6 ad. ♀ paratypes on 2 sl.) UCD; V-14-68, on *C. dactylon,* D. M. Tuttle (5 ad. ♀ paratypes, 2 ad. ♂ paratypes on 2 sl.) UCD, UH; IX-24-68, on *Sorghum* sp. (Gramineae), J. May (5 ad. ♀ paratypes on 5 sl.) CDA; Yuma, s. Gila Valley, X-23-68, on *C. dactylon,* C. Hill and R. A. Flock (7 ad. ♀ paratypes on 4 sl.) CDA. CALIFORNIA, Imperial Co.: Bard, XI-9-67, on *C. dactylon,* D. Harris (1 ad. ♀ holotype on 1 sl., 22 ad. ♀ paratypes on 15 sl.) BM, INIA, MHNCM, UCD, USNM, VPI, ZAS;

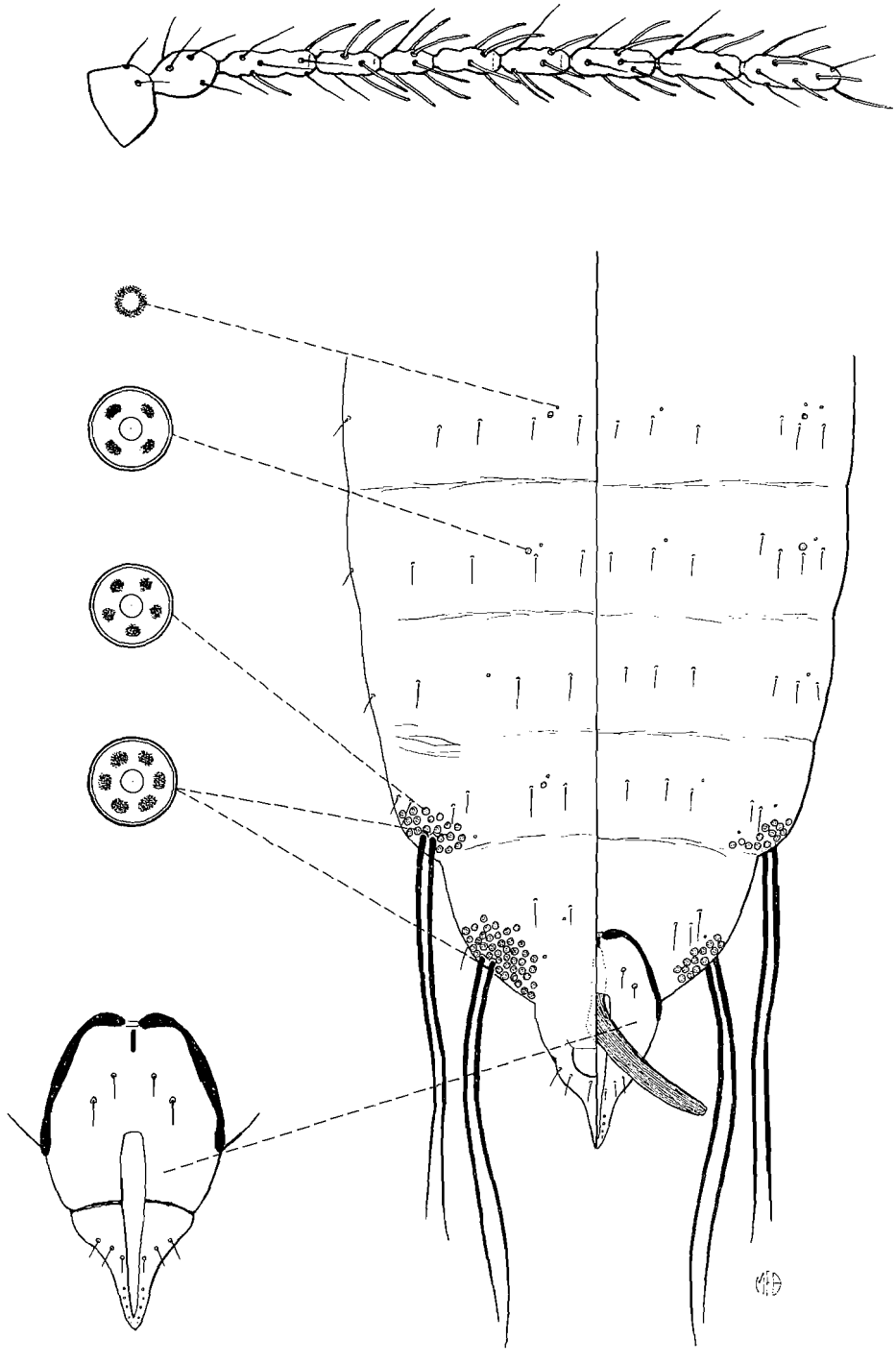

FIG. 5.—Adult male *H. nudus*. (Specimen from Wooster, Wayne County, Ohio, July 10, 1944; on *Phleum* sp. (Gramineae).)

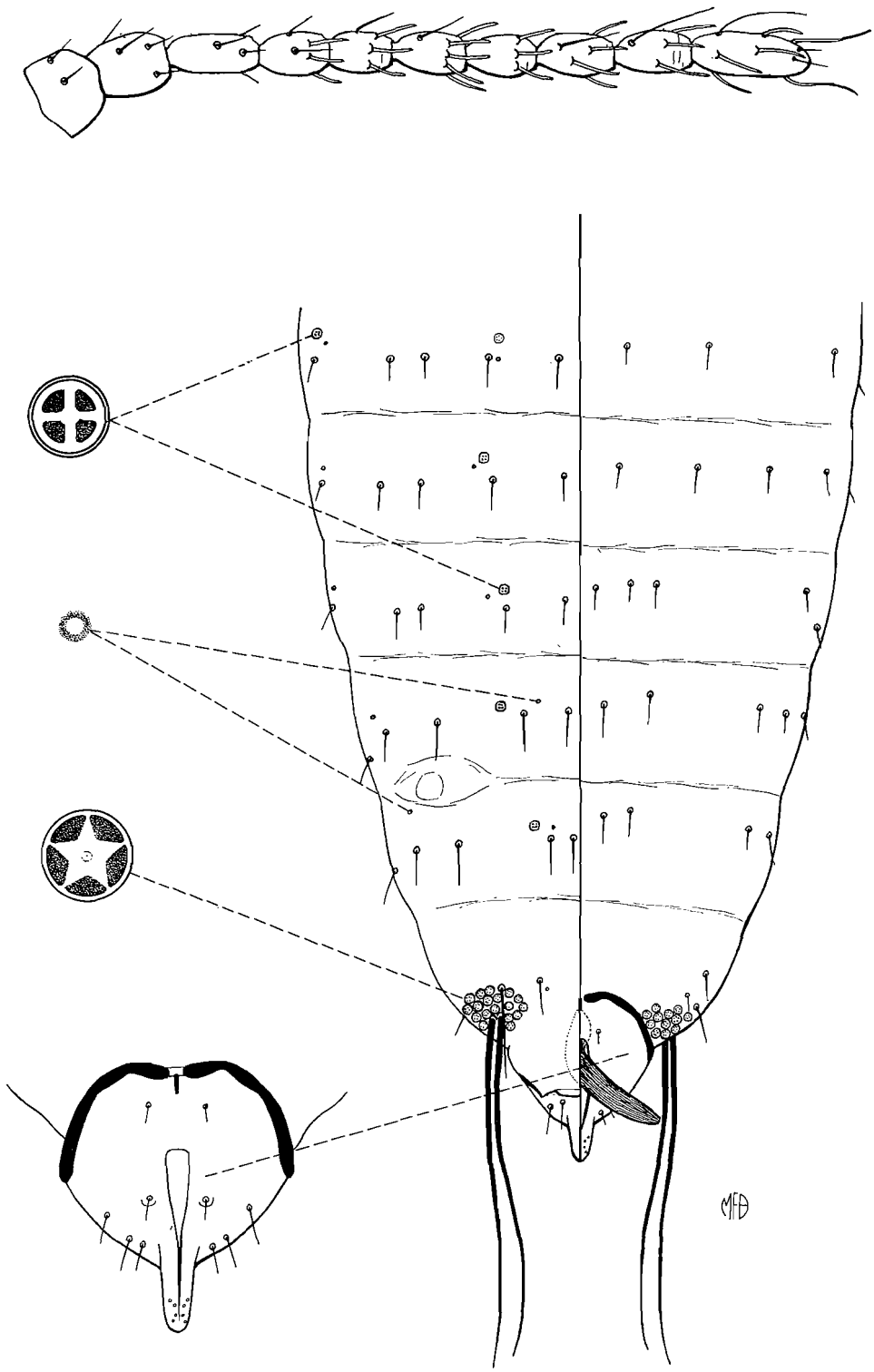

FIG. 6.—Adult male *H. tuttlei*. (Specimen from Yuma, Yuma County, Ariz., May 14, 1968; on *Cynodon dactylon* (Gramineae).)

XII-1-67, on *C. dactylon,* R. A. Flock (8 ad. ♀ paratypes on 6 sl.) CDA, UCD; VI-13-68, on *C. dactylon,* R. A. Flock (5 ad. ♀ on 5 sl.) CDA; El Centro, VII-29-68, on *Sorghum* sp., R. A. Flock (3 ad. ♀ paratypes, 2 ad. ♂ paratypes on 3 sl.) CDA, UCD.

MALES

The males of 2 rather distinct species have been available for study. We thank Miss L. M. Russell for making a paratype male of *H. graminicola* Morrison (= *H. nudus*) available for examination. Since the preparations used for this comparison were relatively poor, it is necessary for us to limit our description to the antennae, wings, and abdomen.

Heterococcus nudus

(Fig. 5)

Adult male, mounted, ca. 1.00 mm long, 0.25 mm wide, all specimens examined are macropterous. Antennae 10-segmented, all segments with filiform setae, segments 3 through 10 with at least 2 digitiform setae.

Head with 3 pairs of eyes. Derm near base of each antenna with 10–12 simple pores. Forewings each bearing 2 or 3 circular pores near basal area of radial vein. Halteres each with single apical seta.

Abdominal segments 8 and 9 each with single pair of pore clusters; each cluster with 2 elongate setae ca. 150 μ long; anterior clusters with ca. 35 stellate pores, posterior clusters with ca. 55; stellate pores in clusters containing 5 or 6 loculi. Abdominal segments 7 through 2 each with 3 or 4 dermal pores, 4–8 simple pores and transverse row of body setae. Dermal pores with 4 or 5 loculi, forming pair of longitudinal lines on medial area of dorsum and along lateral margins. Simple pores associated with rows of body setae. Body setae slightly longer on dorsum, with clusters of 3 or 4 setae along margin of each abdominal segment. Digitiform setae absent on abdomen. Except for penial sheath, abdomen totally unsclerotized. Penial sheath showing signs of division, with transverse indentation dividing sheath into apical one-third and basal two-thirds. Sheath ca. 100 μ long, noticeably slender, with rounded to acute apex which bears several small teeth; ventral opening unclear, over ½ as long as total length of sheath. Aedeagus broad, ca. 65 μ long; basal attachment unclear, appearing to attach to short apodeme. Anal opening apparent dorsally.

Notes.—The presence of 2 pairs of pore clusters and a partially divided penial sheath, as already pointed out by Beardsley (1962), presents a remarkable similarity between this species and *Phenacoccus gossypii* Townsend & Cockerell. Although many characteristics of the males of these species are quite different, their basic similarities support the belief that *Heterococcus* and *Phenacoccus* belong in the same tribe.

Heterococcus tuttlei

(Fig. 6)

Adult male, mounted, ca. 0.90 mm long, 0.20 mm wide; all specimens examined macropterous. Antennae 10-segmented, all segments with filiform setae, segments 4 through 10 with at least 2 digitiform setae, absent on segment 3.

Head with 3 pairs of eyes. Derm near base of each antenna with 7–9 simple pores. Forewings each bearing 1 circular pore near base of radial vein. Halteres each with single apical seta.

Abdominal segment 9 with single pair of pore clusters; each cluster with 2 setae, ca. 165 μ long, and 25–30 quinquelocular type stellate pores. Abdominal segments 8 through 2 each with 2–4 dermal pores, 3 or 4 simple pores, and transverse row of body setae. Dermal pores with 4 or 5 loculi, forming pair of longitudinal lines on medial area of dorsum and rarely along lateral margins. Simple pores forming same longitudinal pattern as dermal pores. Body setae longer on dorsum, with clusters of 2 or 3 setae along margin of each abdominal segment. Digitiform setae absent on abdomen. Except for penial sheath, abdomen totally unsclerotized. Penial sheath undivided. Sheath ca. 70 μ long, noticeably broad, with rounded apex which bears several teeth; ventral opening over ½ as long as total length of sheath. Aedeagus broad, ca. 50 μ long; basal attachment to short apodeme on ventral surface of sheath. Anal opening apparent dorsally, with lower lip appearing sclerotized.

Notes.—The male is quite different from the male of *H. nudus* in possessing: only 1 pair of pore clusters; and broad, undivided penial sheath with rounded apex. *H. nudus,* on the other hand, possesses: 2 pairs of pore clusters; and slender, divided penial sheath with acute apex.

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